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Operating Instructions

231A

R.F. POWER METER

TYPE TF.1205.

*500
watts*

SER JA 141/067

MARCONI INSTRUMENTS LIMITED, ENGLAND

OPERATING INSTRUCTIONS

for

R. F. POWER METER

TYPES TF 1205 and TF 1205/S

This handbook is issued for use with Instrument
Serial No. *AM11/064* The figures given on p 9
and 16 apply to this particular instrument only.

INDICATOR METER TM 5568
Ser JA141/64

TF 1205/S only:

Joint-Service Designation

Wattmeter Absorption (R. F.), Type CT 401

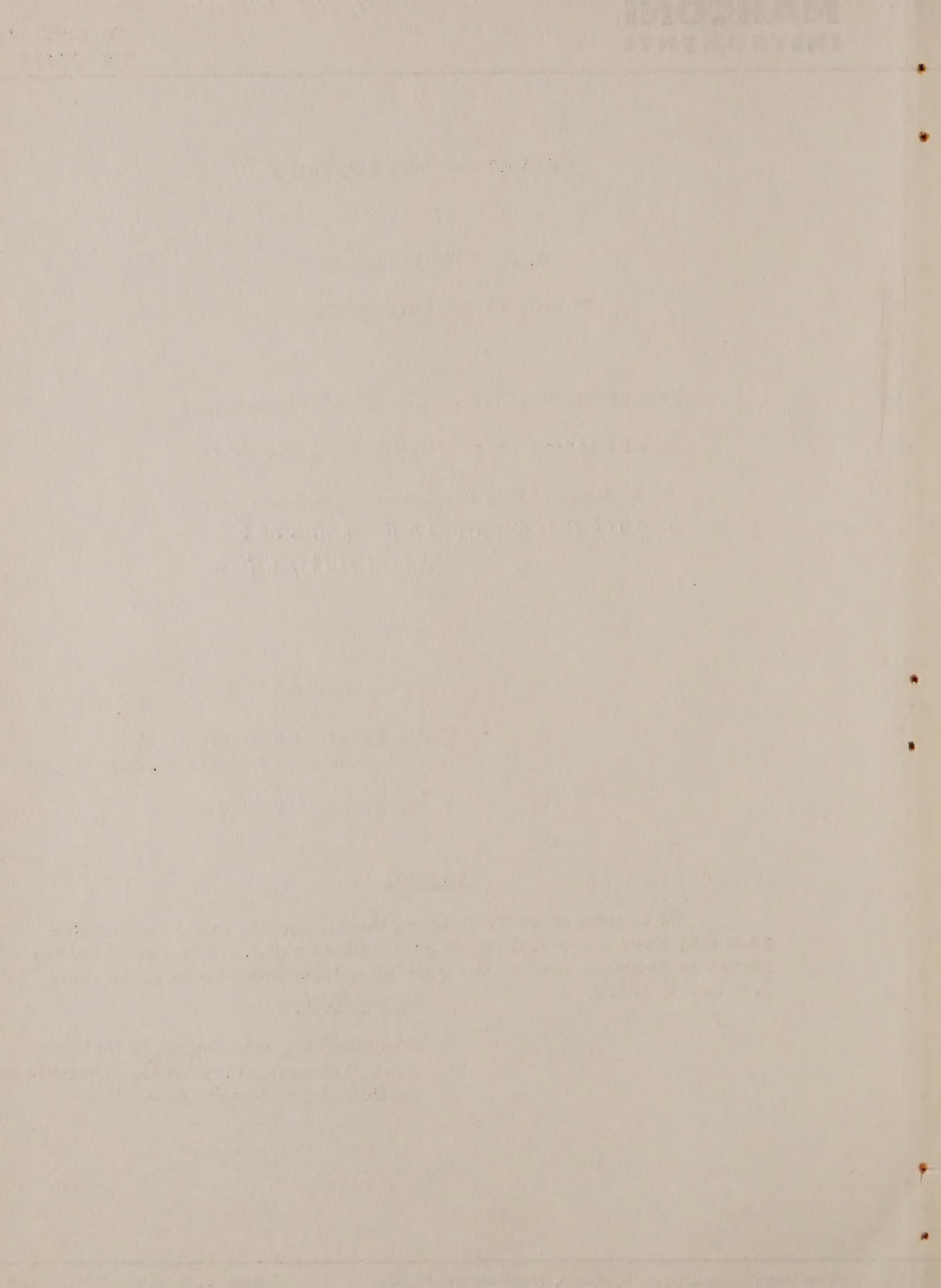
A. M. Ref. No. 10S/16846

WARNING

Be careful to avoid touching the oil used in this Power Meter
as it may have a harmful effect on sensitive skins. The use of rubber
gloves is recommended when carrying out the procedures in Sections
3.1.1. and 3.1.3.

Amendments

The following amendment is included
at the commencement of the Appendices
section of this handbook: AM1



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SCHEDULE OF PARTS SUPPLIED

TF 1205

1. One R.F. Power Meter Type TF 1205, complete with attached Indicator Unit Lead.
2. One Indicator Unit Type TM 5568.
3. One Signal Input Plug, Coaxial, Type N.
4. One Indicator Unit Shorting Plug, Bulgin Type P505.
5. One 3/16" A/F Hexagonal Socket Wrench, in linen bag.
6. One Instruction Book No. EB 1205 -/S

TF 1205/S

1. One R.F. Power Meter Type TF 1205/S, complete with attached Indicator Unit Lead.
2. One Indicator Unit Type TM 5568/1.
3. One Coaxial Input Lead Type TM 5581.
4. One Elbow Adapter, Coaxial, Type N.
5. One Wavemeter 'T' Connector Type TM 5656.
6. One Indicator Unit Shorting Plug, Bulgin Type P505.
7. One 3/16" A/F Hexagonal Socket Wrench, in linen bag.
8. One Instruction Book No. EB 1205 -/S.

EXHIBIT 1

10-10-10

1. The first item is a letter from the Secretary of the Board of Directors to the Board of Directors, dated 10-10-10.
2. The second item is a letter from the Secretary of the Board of Directors to the Board of Directors, dated 10-10-10.
3. The third item is a letter from the Secretary of the Board of Directors to the Board of Directors, dated 10-10-10.
4. The fourth item is a letter from the Secretary of the Board of Directors to the Board of Directors, dated 10-10-10.
5. The fifth item is a letter from the Secretary of the Board of Directors to the Board of Directors, dated 10-10-10.
6. The sixth item is a letter from the Secretary of the Board of Directors to the Board of Directors, dated 10-10-10.

10-10-10

1. The seventh item is a letter from the Secretary of the Board of Directors to the Board of Directors, dated 10-10-10.
2. The eighth item is a letter from the Secretary of the Board of Directors to the Board of Directors, dated 10-10-10.
3. The ninth item is a letter from the Secretary of the Board of Directors to the Board of Directors, dated 10-10-10.
4. The tenth item is a letter from the Secretary of the Board of Directors to the Board of Directors, dated 10-10-10.
5. The eleventh item is a letter from the Secretary of the Board of Directors to the Board of Directors, dated 10-10-10.
6. The twelfth item is a letter from the Secretary of the Board of Directors to the Board of Directors, dated 10-10-10.

1.

DESCRIPTION

1.1 GENERAL

The Marconi TF 1205 is a direct-reading absorption-type R.F. Power Meter, for use at any frequency from d.c. to 500 Mc/s. It measures true mean power, irrespective of waveform, up to 500 watts.

Intended for direct connection to a coaxial cable, the instrument has an input impedance of 50 ohms. Its v.s.w.r. is less than 1.15 up to 250 Mc/s, and less than 1.35 at 450 Mc/s. With the use of the correction factors given in page 9 and AML, the indication is accurate to within 5% of meter f.s.d. from d.c. to 150 Mc/s, and $7\frac{1}{2}\%$ of f.s.d. from 150 to at least 300 Mc/s; there is not abrupt change in performance above 300 Mc/s, and the instrument can be used satisfactorily up to 500 Mc/s.

The indicating section of the instrument is a small separate unit, connected by a six-foot length of cable to the main unit. The Indicator Unit may thus be used a short distance away from the main body of the instrument.

The load element is oil-immersed, and the finned outer casing is cooled by free air convection. The instrument is completely self-contained and transportable.

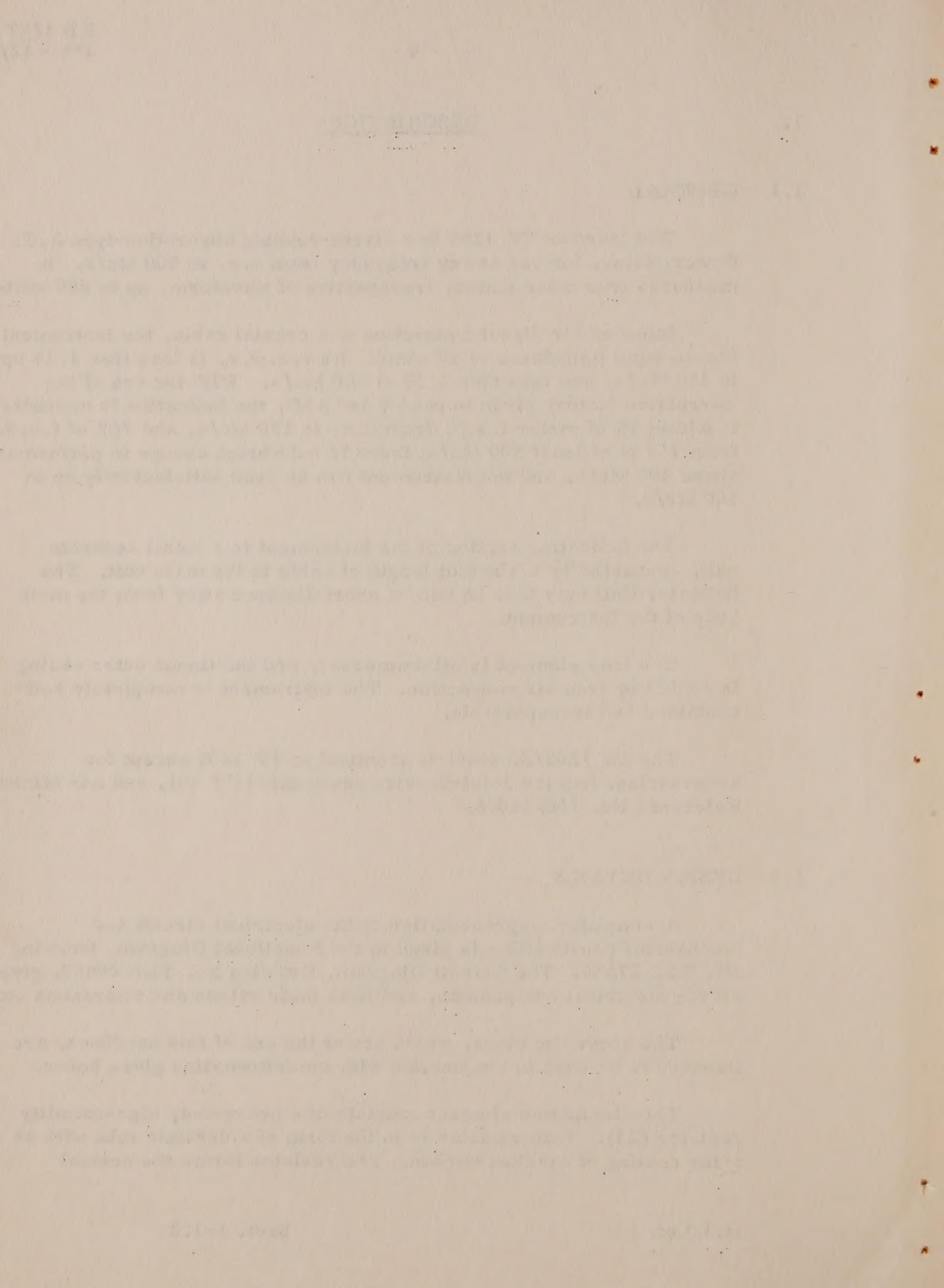
The TF 1205/S, which is identical to TF 1205 except for accessories, has the Joint-Service designation CT 401, and Air Ministry Reference No. 10S/16846.

1.2 DESIGN DETAILS

A simplified representation of the electrical circuit and mechanical construction is given in the Functional Diagram, Drawing No. TLC 27640. The Circuit Diagram, Drawing No. TLB 29559, gives all the electrical components, and lists their values and tolerances etc.

The above drawings, which are at the end of this handbook, are intended to be used in conjunction with the information given below.

The dissipative element consists of a heavy-duty high-stability resistor (R1). This resistor is in the form of a ceramic tube with an outer coating of cracked carbon. The resistor forms the central



1.2. (continued)

conductor of a 'slab' transmission line.

Connection from the source of power is made to a type N coaxial socket, the input being fed to the 'live' end of the load resistor by an outward-taper, constant-impedance section of slab-line. From a point in line with the 'live' end of the resistor, the broad cast metal plates which form the outer ('earthy') conductor of the slab line gradually converge down the length of the resistor, and are clamped to its far end. This specially-shaped convergent section matches the transmission line to the resistor throughout its length, decreasing the impedance of the line along the length of the resistor coincidentally with the decrease in resistance along the resistor towards earth; this results in an almost reflection-free resistive termination.

Efficient cooling of the load resistor is obtained by immersing the complete slab-line assembly in a tank of transformer oil. The tank is heavily finned for good heat-dissipation. This cooling arrangement allows continuous rating of the instrument at its highest power without the need for further cooling assistance. Two special compensators are fitted, to allow expansion of the oil when hot. Each compensator consists of a long hollow cylindrical rubber bulb which is open at one end. The bulb is placed inside the oil tank, and its open end is sealed to a small opening in the bottom of the tank. The inside of the bulb is thus open to atmospheric pressure. When the pressure inside the tank (and hence outside the bulb) rises, the bulb tends to collapse due to the internal/external pressure-differential. The oil thus effectively displaces the air in the bulb. A spring-loaded pressure-relief valve is also fitted, so that any excessive expansion which cannot be handled by the compensators may be relieved.

Power level is indicated by means of a vacuum thermocouple and a moving-coil meter. The heater of the thermocouple is fed from a tap near the 'earthy' end of the load resistor. To compensate for the sensitivity/temperature characteristic of the thermocouple, a thermistor is included in its output lead; this offsets the effect of a decrease in the thermocouple output as the oil temperature rises during measurements, and maintains a constant meter reading for a given power input.

The Indicator Unit, which includes the meter, a preset sensitivity control, and a thermistor-shunting resistor (R5), is a separate unit, and may be clipped on or detached from the main body of the instrument;

1.2. (continued)

connection between the main body and the Indicator Unit is made via a six-foot length of screened cable.

The meter has a full-scale deflection of 1 mA, and is calibrated from 0 to 500 watts. The front face of the Indicator Unit is covered by a hinged transparent 'Perspex' plate which protects the meter face.

2. OPERATION

2.1. GENERAL

The output from the thermocouple is directly proportional to the power in the 50-ohm load. Therefore, the meter deflection is proportional to true mean power, irrespective of waveform. Thus, power contained in harmonics of the input is correctly summed with the fundamental; furthermore, since the meter will indicate the correct increase in power when a.m. is applied to a previously unmodulated input signal, modulation depth can be calculated - see Section 2.5.

2.2. CONNECTIONS

The power input connector is a Type N jack, and mates with a Type N (50 ohm) free plug, one of which is supplied with the instrument; in the TF 1205/S version, the plug is supplied complete with a coaxial lead terminated with a free socket, Joint Service ref. No. Z560044 (Burndep't Part No. 45945) at the other end. The TF 1205/S is also supplied with a Type N Elbow Adapter (plug/socket).

A special 'T' connector is supplied with the TF 1205/S; this may be interposed between the power input jack and the incoming plug to allow connection to a wavemeter. The outlet for the wavemeter is a Type BNC jack and mates with a Type BNC (50 ohm) free plug.

The type numbers of the jacks and mating plugs, and of cables for use with the plugs, are as follows:-

<u>Input Jack:</u>	Type N; Transradio Ltd. Code No. BEa 071/50. U.S. Military No. UG-23 B/U.
Mating Plug:	Type N (50 ohm); Transradio GEa 071/50, (UG-21 B/U).
Cable:	Uniradio 67, (RG-8/U, -9/U, or -10/U).
<u>Elbow Adapter</u> (Plug/Socket):	Type N (50 ohm); Transradio LEa 071/50, (UG-27A/U).
<u>Wavemeter Jack:</u>	Type BNC; Transradio Ltd. Code No. BN 1/5. U.S. Military No. UG-89/U.

2.2. (continued)

Mating Plug: Type BNC (50 ohm); Transradio BN 1/5,
(UG-88/U).

Cable: Uniradio 43, (RG-55/U).

Connection between the main body of the instrument and the Indicator Unit is made by means of a six-foot cable permanently connected to the main unit, and terminated in a telephone plug which is inserted into a jack mounted on the side of the Indicator Unit case.

2.2.1. Adjustment of Signal Level to Wavemeter

The wavemeter outlet on the special T-connector supplied with the TF 1205/S is fed via an internal movable pick-up probe, whose position can be adjusted so that a convenient signal-level is fed to the wavemeter. To adjust the signal level, rotate the knurled nut on the wavemeter outlet arm; rotate the nut in a clockwise direction to increase the signal level to the wavemeter.

2.3. INDICATOR UNIT FIXING

In operation, the Indicator Unit may be separated from the main unit to the extent of the cable, or it may be fixed to the lifting bridge which spans the top of the main body casting of the instrument; this latter position is used when transporting the Power Meter. The Indicator Unit is fixed to the lifting bridge by fitting the slot in the rear of its case over the upper edge of the lifting bridge, and inserting the securing peg which clicks into position. The peg is connected to the main unit by a short length of stranded wire to prevent its loss when not in use. The Indicator Unit can be fixed to either side of the bridge as convenient; the unit is adequately protected from heat rising from the cooling fins. Two spring clips are provided on the side of one of the end cooling fins in order that the Indicator Unit connecting cable may be conveniently coiled onto the main unit. As a precautionary measure against meter damage a shorting plug is provided for insertion into the input jack of the Indicator Unit during transit.

2.4. MAKING A POWER MEASUREMENT

Connect the telephone-plug lead on the main unit to the jack on the Indicator Unit.

2.4 (continued)

Connect the source under test to the coaxial socket at the base of the instrument; the mean power input can then be read directly on the meter.

Due to manufacturing tolerances in the cast plates of the slab line, the calibration accuracy tends to decrease slightly with increasing frequency. Below are given the correction factors applicable to the instrument with which this handbook is issued.

At 200 Mc/s multiply meter reading by 1.1111.....

At 250 Mc/s multiply meter reading by 1.1111.....

At 300 Mc/s multiply meter reading by 1.1111.....

When using the Power Meter, the following points should be borne in mind:-

- 1) Although there will be no loss of oil if the instrument is put into a position other than vertical, it must be in a vertical position when power is being measured, in order to allow proper air-convection round all the cooling fins; otherwise overheating may occur.
- 2) It must be emphasized that the meter indication always corresponds to the power being dissipated within the Power Meter. However, this does not imply that an accurate power measurement is achieved unless the power source accurately matches the load. For optimum measurement accuracy, the power source should be adjusted for maximum power transfer. (See also p 16).
- 3) There is, unavoidably, a small time-lag between the application of power and the meter indication becoming steady. This is due partly to the heating time of the thermocouple, and partly to meter damping caused by the low-resistance meter circuit. After the initial application of power or any change in power level, therefore, it is good practice to wait two or three seconds for the meter reading to stabilize.
- 4) The peak voltage which may safely be applied to the Power Meter is limited by the insulation of the coaxial connecting plug; this is rated to withstand a maximum of 500 volts. The maximum peak power that may be applied is accordingly of the order of 5 kW. The thermocouple will withstand overloads equivalent to 750 watts mean power input to the instrument (i.e., 50% overload).

2.4 (continued)

- 5) Although the instrument may safely be operated at maximum power dissipation for extended periods, the attendant overall temperature rise may cause indication errors.

With the instrument operating at full power for 2 hours, indication may change by about $\pm 2\%$ of full scale. Since this error is dependent upon the temperature rise, it will be of a lower order after prolonged operation at powers less than 500 watts. Normal accuracy will be regained when the instrument is allowed to cool.

2.5 DETERMINATION OF MODULATION DEPTH

The depth of amplitude modulation of an r.f. signal having a sinusoidal envelope can be determined as follows:-

- 1) Measure the output power of the source under test with the signal unmodulated. Let this reading be P_C watts.
- 2) Modulate the signal, and again measure the output power. Let this reading be P_M watts.
- 3) Calculate the modulation depth. This can be evaluated since P_C , P_M , and the modulation factor, m , are related by

$$P_M = P_C (1 + m^2/2) \dots\dots\dots (1)$$

Transposing and simplifying, Equation (1) gives

$$\text{Modulation Depth} = \sqrt{\frac{2 (P_M - P_C)}{P_C}} \times 100\% \dots\dots\dots (2)$$

Example: From measurements, it is found that $P_C = 55$ watts, and $P_M = 75$ watts.

$$\begin{aligned} \text{From Equation (2),} \\ \text{Modulation Depth} &= \sqrt{\frac{2 (75 - 55)}{55}} \times 100\% \\ &= \underline{85.5\%} \end{aligned}$$

2.5 (continued)

In this method it is assumed that no change in carrier level occurs in the source under test when modulation is applied. If this effect is present, the result obtained from equation (2) will be lower than the actual depth of modulation.

3.

MAINTENANCE

3.1. GENERAL

Owing to the robustness and inherent simplicity of the instrument, very little maintenance is likely to be required. If, however, it is considered necessary to check the calibration of the instrument, or replace or top-up the oil in the tank, the procedures given below should be adopted.

3.1.1. Replacement of Oil

To replenish or change the oil in the instrument, proceed as follows:-

NOTE: Do not attempt to remove the oil filler plug unless the instrument is cool.

- (1) If the Indicator Unit is clipped to the main body of the Power Meter, remove it and put it aside.
- (2) Invert the main body and, using a 9/16" Whitworth spanner or equivalent, unscrew and remove the filler-plug, being careful not to damage the special washer.
- (3) Fill with oil, well up to the screw threads, using Shell 'Diala B' transformer oil. The oil must be clean, and should be filtered and freed from moisture-content before use. Transformer oils other than Shell 'Diala B' may be used, providing their electrical and physical properties are the same.

Filling can best be accomplished using a syringe or funnel.

To drain the instrument of oil, a length of thin plastic tubing should be inserted well into the tank through the filler hole, before the instrument is reverted over a suitable receptacle. This will prevent the formation of air-locks, and ensure smooth pouring.

The tank holds approximately 1.7 imperial gallons (7.7 litres) of oil.

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3.1.2. Checking the Calibration of the Instrument

The accuracy of calibration may be checked, or the instrument may be re-standardized, by feeding in measured power at d.c., at mains frequency, or at any other convenient frequency. If necessary, the meter sensitivity may be adjusted by means of the preset control on the front face of the Indicator Unit. This control is accessible when the hinged plastic protective plate over the front face of the Indicator Unit is hinged down, and the small dome in the recess below the meter face is unscrewed and removed.

3.1.3. Replacement of Thermocouple and Thermistor

To gain access to the thermocouple and the thermistor, it will be necessary to remove the complete load assembly from the oil-filled tank; for a clean operation, the oil should be drained off (see Sect. 3.1.1) and the instrument should then be inverted and left for a few minutes to drain oil off the load assembly into the top of the oil tank.

To remove the load assembly, proceed as follows:-

- (1) With the instrument still inverted, remove the screws which secure the rubber feet to the body. This will release the feet and the cut-out square plate beneath, which should be removed.
- (2) Using a suitable sized socket wrench, remove all 24 screws and washers from the periphery of the base plate. The base-plate with the load assembly can now be withdrawn from the oil tank, and should be placed on a clean surface.

The thermocouple assembly is mounted on a machined aluminium block on one side of the flat cast slab-line, near the 'earthy' end of the load resistor. The thermistor is mounted on stand-off insulators, with the r.f. filter inductors and stand-off capacitors on one edge of the aluminium block.

To remove the thermistor, simply unsolder it from its stand-off insulators - this can be carried out without removing the block from the load assembly.

NOTE: If the thermistor is replaced, it may be necessary to replace the shunting resistor (R5), which is mounted in the Indicator Unit, with a resistor of different value, since this resistor is selected to suit the

3.1.3. (continued)

individual thermistor. The resistor modifies the effect of the thermistor, and its value is chosen so that the nett resistance/temperature characteristic exactly compensates for the effect of oil temperature on the thermocouple; that is, so that the meter reading for a given power input does not change as the oil warms up.

To gain access to the thermistor shunt resistor, remove the three small self-threading screws from the periphery of the rear panel on the Indicator Unit. Remove the panel to expose the shunt resistor, which is secured by means of a 4-BA screw and nut - only the nut need be unscrewed in order to extract the resistor.

To remove the thermocouple, proceed as follows:-

- (1) Unsolder the connection between the wire which protrudes from the groove at the uppermost end of the thermocouple block and the wire which protrudes through the load assembly casting from the load tapping point.
- (2) Unscrew and remove the two 4-BA nuts which secure the block to the load assembly casting.
- (3) Remove the block, taking care not to pull the leads which connect the block to the d.c. output terminals at the base of the load casting.
- (4) Now unsolder the thermocouple from its connections on the underside of the block.

NOTE: When fitting a replacement thermocouple, make sure that, when soldering it into position, it is suspended clear of the sides of the cavity into which it fits.

Reassembly Note:

In order to ensure an oil-tight seal between the base plate and main casting, it is essential that both surfaces are absolutely clean, and that the gasket is in good condition.

Insert the 24 fixing screws and, having made sure that washers are fitted beneath the screw heads, tighten them by an equal amount with

3.1.3. (continued)

the fingers. The socket wrench should then be employed in a manner similar to that used for tightening the cylinder-head bolts of a car engine - the diametrically-opposite screws should be tightened, a small amount at a time, in order to avoid the possibility of distortion. Gradually increase the loading on the screws until they are just sufficiently tight to give an oil-tight seal. Do not overtighten - this could lead to stripped threads in the tapped holes of the magnesium alloy casting.

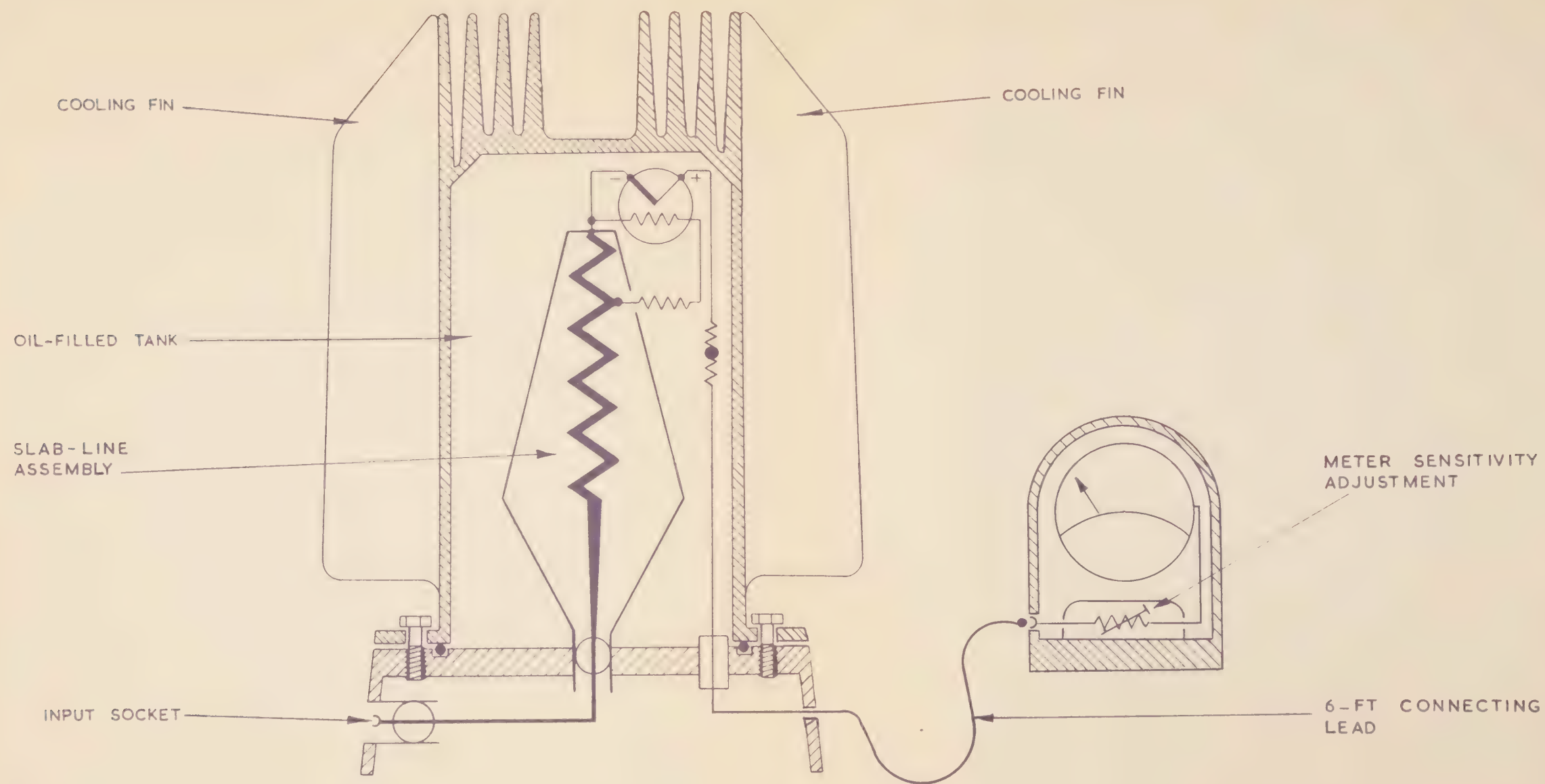
AMENDMENT NO. 1CORRECTION FOR SCALE SHAPE

For maximum accuracy in the instrument with which this handbook is issued, the correction factors given below should be applied to the meter calibration. This offsets any errors due to the meter scale shape and thermocouple characteristic. Replacement of either meter or thermocouple will invalidate these correction factors.

Meter Reading	Multiply Reading By
100	1.0
200	1.01
300	1.02
400	1.02
500	1.01

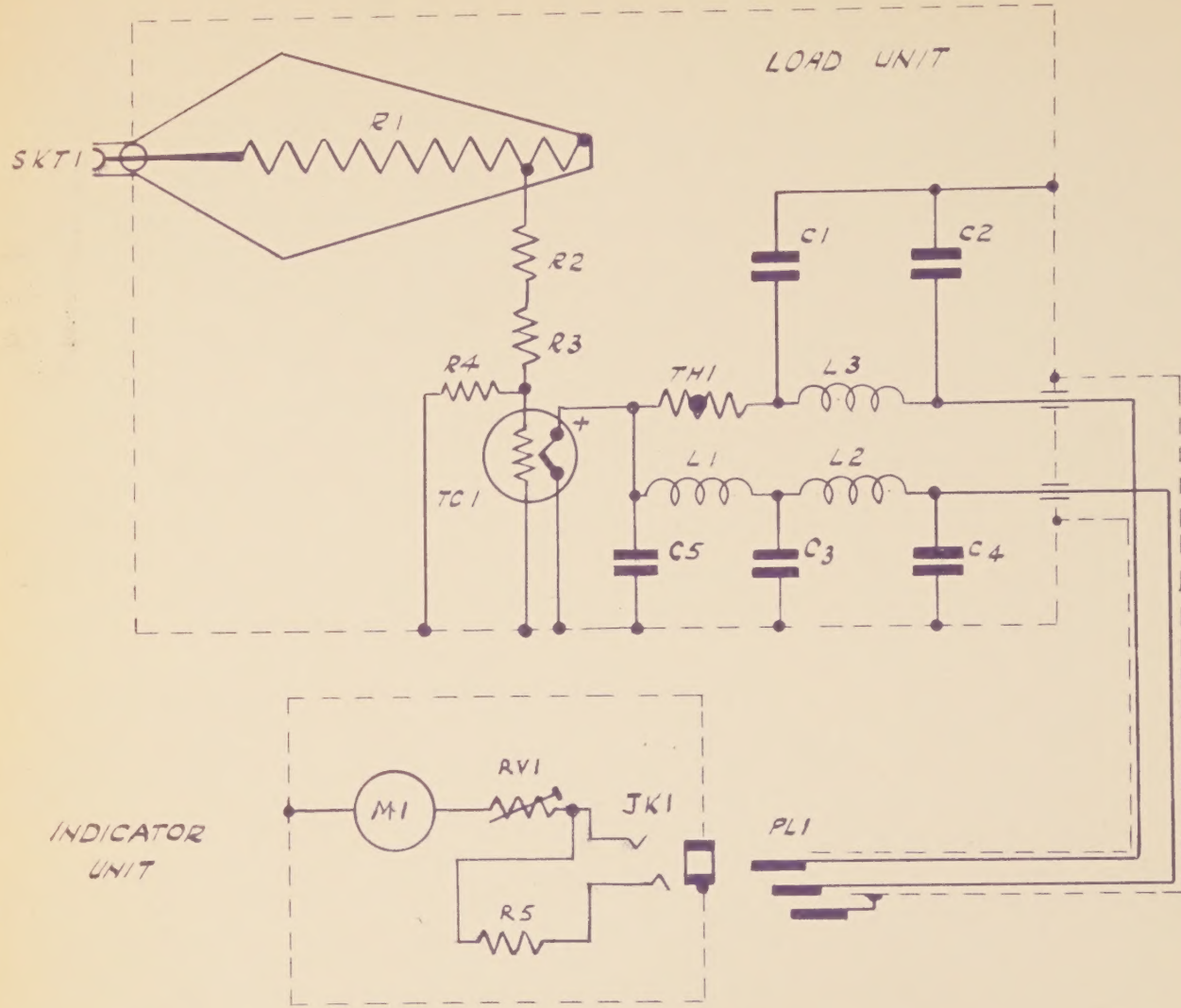
FUNCTIONAL DIAGRAM
 OF
 R.F. POWER METERS
 TYPES TF 1205 AND TF 1205/S

MARCONI INSTRUMENTS LIMITED							
DRN	G. R. G.	DATE	11.11.57	CHKD	G R G.	ISSUE	2
STOCK LIST	TF1205			DRG No	TLC 27640		



FUNCTIONAL DIAGRAM OF R.F. POWER METERS TYPES TF 1205
AND TF 1205/S

CIRCUIT DIAGRAM
OF
R.F. POWER METERS
TYPES TF 1205 AND TF 1205/S



REF.	DESCRIPTION	S. LIST REF.	REF.	MISCELLANEOUS	S. LIST REF.
R1	50Ω ± 5%	13/TM 5580	C5	1000pF ± 20%	33/TM 5580
R2	100Ω ± 5% ¼ W.	28/TM 5580			
R3	80Ω ± 5% ¼ W.	29/TM 5580	L1	CHOKE	26/TM 5580
R4	18Ω ± 5% ¼ W.	30/TM 5580	L2	CHOKE	26/TM 5580
R5	6.1Ω W/W SPECIAL	31/TM 5580	L3	CHOKE	26/TM 5580
			TC1	THERMOCOUPLE	12/TM 5580
RV1	25Ω ± 10% ¼ W.	8/TM 5568	PL1	JACK PLUG	30/TM 1205
			JK1	PANEL JACK	12/TM 5568
			SKT1	SOCKET, SPECIAL	TM 5580
C1	1000pF ± 20%	33/TM 5580			
C2	1000pF ± 20%	33/TM 5580	M1	METER 0-1mA	1/TM 5568
C3	1000pF ± 20%	33/TM 5580	TH1	THERMISTOR	27/TM 5580
C4	1000pF ± 20%	33/TM 5580			

MARCONI INSTRUMENTS LIMITED							
DRN	M. C.	DATE	12/58	CHKD		ISSUE	4
STOCK LIST		TF 1205-S		DRG No.		TLB 29559	

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